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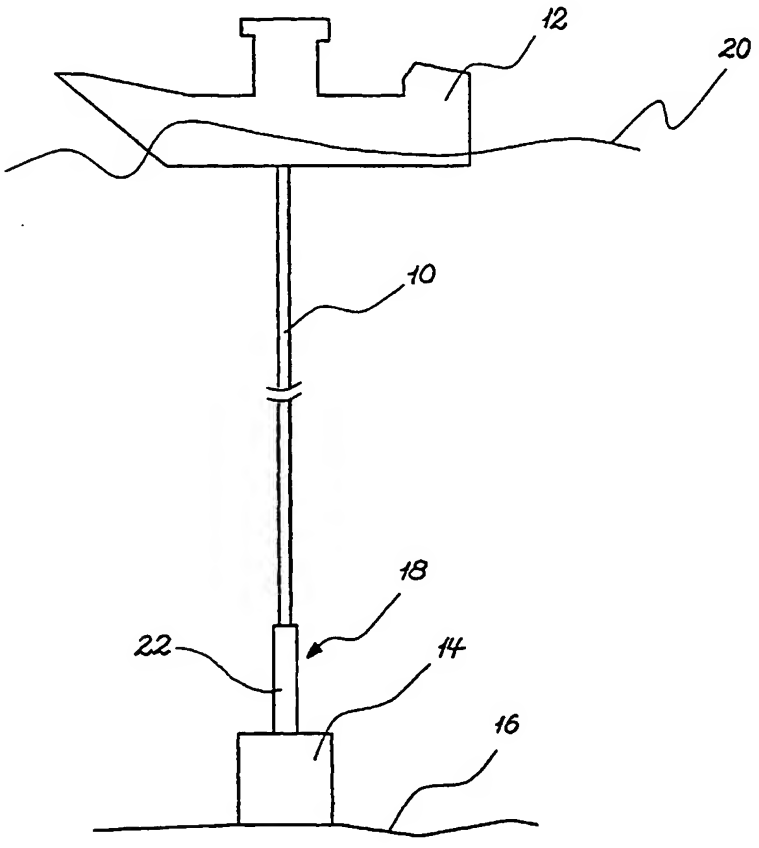
(54) Title: TENSIONING AND HEAVE COMPENSATING ARRANGEMENT AT A RISER



(57) Abstract: A special installation of a riser (10) that extends between an item of subsea equipment (14) and a surface vessel (12) has been described, which installation in particular is intended for use in connection with offshore oil extration, and in which the rise (10) is provided with a telescopic section. For the purpose of heave compensation, the riser (10) is installed in a manner such tat said telescopic section (18) is located at the lower end of the riser (10), heave compensation being effected by the telescopic mobility of the riser (10), while the mass of the riser (10), when suspended in this manner, keeps the rise (10) tensioned.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

TENSIONING AND HEAVE COMPENSATING ARRANGEMENT AT A RISER

The present invention regards a tensioning and heave compensating arrangement at a riser that extends between an item of subsea equipment and a surface vessel, in which the riser forms part of a telescopic pipe arrangement.

Risers of this type have their lower end attached to subsea equipment such as blowout preventer valves, wellheads or similar, and the top attached to a surface vessel, such as a drillship or a platform.

In order to absorb the vertical heaving motion of the vessel caused by the motion of the sea, it is previously known to provide the upper end section of the riser with a piece of piping that is arranged so as to slide telescopically in the riser. I.e., the riser has a telescopic pipe section at the top.

The riser must be kept under continuous tension, and in the case of known risers this is achieved by means of a steel wire that is attached to the riser and kept taut by means of

winches or hydraulic/pneumatic cylinders that have been assigned pressure sources and accumulators located on board the surface vessel. The direct use of hydraulic/pneumatic cylinders, i.e. without a steel wire, is also known. The winches must be sized to take up the weight of the riser and any fluid present in this. Moreover, the winches must be controllable, so called heave compensatable (vertical motion compensatable), so as to minimise the transfer of heaving movements from the surface vessel to the riser.

Considerable disadvantages and drawbacks are associated with the prior art within the relevant area. Thus it has proven difficult to control the tension in the riser, and during heavy seas the connection between the riser and the subsea equipment may become overtensioned.

In the case of subsea operations through use of risers at great depths and with correspondingly long risers, designed and supported in accordance with prior art, the heave compensating suspension arrangement will require a winch of considerable capacity, which complicates and makes the surface vessel more expensive.

The object of the invention has been to provide a tensioning and heave compensating arrangement at a riser, which arrangement does not require the use of winches in order to keep the riser tensioned or to achieve heave compensation.

This object is realised according to the invention, by arranging a riser of the type mentioned at the beginning in accordance with the characterising part of Claim 1.

Known risers of the relevant type are, as mentioned, provided with a telescopic section at the top.

Unlike the known emplacement of said telescopic section, a telescopic section is present at the lower end of a riser that is designed and arranged in accordance with the invention. Thus, the lower part of the riser according to the invention forms part of a telescopic pipe arrangement in the area of the subsea equipment as an inner, telescopically movable pipe.

A riser according to the invention is at the top secured to the surface vessel in a known manner, and follows the movements of the vessel caused by the motion of the sea, while the mass of the riser ensures that the riser is kept under tension. By so doing, an advantageous technological double effect is achieved by use of simplified and inexpensive means.

The telescopic section of the riser may be realised with or without pretensioning that contributes towards increasing the tension in the riser.

Non-limiting examples of three preferred embodiments are explained in greater detail in the following part of the description, with reference to the accompanying drawings, in which:

Figure 1 schematically shows a side view of a riser extending between a blowout preventer valve on the seabed and a surface vessel;

Figure 2 shows an enlarged side view, partly in section, of the lower part of the riser that forms part of a telescopic pipe arrangement placed below;

Figure 3 corresponds to Figure 2, however here said telescopic pipe arrangement is spring-pretensioned in the axial direction;

Figure 4 shows a third embodiment of the lower telescopic pipe arrangement, which in this case is pretensioned through use of hydrostatic pressure.

Figure 1 shows a schematic diagram of a riser 10 extending between a surface vessel 12, such as a drillship, and an item of subsea equipment 14, such as a blowout preventer valve on the seabed 16.

A lower telescopic riser section in the form of a telescopic pipe arrangement is generally denoted by reference number 18. The surface of the sea is indicated by 20.

The telescopic pipe arrangement 18, in which the outer pipe is denoted by 22 and the inner pipe consists of the riser 10, allows the riser to perform vertical movements up and down as a result of the motion of the sea acting on the surface vessel 12 and lifting/lowering this. It is the magnitude of the vertical movements of the vessel that must be absorbed by the telescopic pipe arrangement through the movement of the lower end portion of the riser in the outer telescopic pipe 22.

In the case of such an arrangement, in which the telescopic riser section is located at the bottom, the mass of the riser 10 will maintain the tension in the riser. This avoids the use of high capacity winches for tensioning the riser catlines in accordance with prior art.

The general arrangement in Figure 1 applies to all three embodiments shown in 2, 3 and 4 respectively.

Figure 2 shows a first embodiment of the invention, in which an internal annular packing 24 that has been arranged so as to provide a sliding seal between the inside of the outer telescopic pipe 22 and the outside of the riser 10, is disposed at the top of the outer telescopic pipe 22, the outer telescopic pipe 22 in the telescopic pipe arrangement 10, 22 being sufficiently dimensioned for extension in the vertical direction to accommodate the maximum vertical movements anticipated from such a surface vessel.

Figure 3 shows a second embodiment of the invention, in which the telescopic pipe arrangement 18 at the lower end of the riser 10 is spring-pretensioned. Reference number 26 indicates a helical line-shaped compression spring, the upper end of which abuts the lower surface of an upper, inwardly directed ring flange 22' of the outer telescopic pipe 22, and the lower end of which abuts the upper surface of a shoulder 30 on the lower end of the riser 10. An annular packing 28 provides a sliding seal against the riser 10.

In addition to the tension effected by the mass of the riser 10, further tension is applied to the riser 10 by the pretensioned spring 26 acting between its said abutment surfaces

An alternative embodiment shown in Figure 4 represents a third embodiment of the invention.

Here, longitudinal sections of the outer pipe in the telescopic pipe arrangement 18 have been constructed with different inner and outer diameters. Thus, both the inner and the outer diameters of an upper axial pipe section 22a are larger than those of a lower axial pipe section 22b. The pipe section 22a forms a cylinder for a piston 32 with a peripheral packing 34 that provides a sliding seal against the inside of the cylinder 22a. A circumferential packing 36 that provides a sliding seal against the lower end portion of the riser 10 is disposed internally at the transition between the two axial pipe sections 22a and 22b.

By this arrangement, a cylindrical chamber 38 is formed between the lower surface of the piston 32 and the upper surface of the packing 36 and of an adjacent, inwardly oriented annular part 40 at the above mentioned transition.

The upper surface of the piston 32 is exposed to the pressure in the surrounding water, while the underside of the piston 32 is exposed to the pressure in the cylindrical chamber 38.

A radially oriented vacuum pipe 42 in communication with the lower end of the cylindrical chamber 38 is connected to a set of pumps (not shown) arranged so as to be able to evacuate the cylindrical chamber 38. Thus, the pressure of the water at the top of the piston 32 results in a downward acting force being applied to this, and by so doing contributes towards tensioning the riser 10.

It is easy to appreciate that the telescopic pipe arrangement 18 may also be pretensioned by other means than those shown and described, for example by means of hydraulic pressure accumulators and subsea winches. It is also easy to appreciate that it will be possible to implement this pretensioning by using various combinations of pretensioning means.

C l a i m s

1. Arrangement at a riser extending between an item of subsea equipment (14) and a surface vessel (12), e.g. a drillship, for heave compensation and tensioning of the riser (10), in which the riser (10) as compensating means for vertical movement is constructed with a telescopic riser section (18) located at the lower end part of the riser (10), and in which the lower part of the riser string constitutes an inner, telescopically movable pipe that is enclosed, at least partially in the longitudinal direction, by an outer telescopic pipe (22; 22a, 22b), the lower end of which is connected to said subsea equipment (14), the telescopic riser section (18) effecting the heave compensation of the riser (10), while tensioning of the same is achieved through the weight of the riser (10) on its own or combined with pretensioning means connected to the telescopic riser section (18) at the lower end of the riser string, w h e r e i n the lower part of the riser string (10), which forms a telescopically movable inner pipe in the telescopic section (18) and is enclosed by the outer telescopic pipe (22; 22a, 22b), supports a transverse, annular disc-shaped flange (30; 32), the upper surface of which is designed to be pressure loaded for the purpose of pretensioning, hydraulically by means of the water pressure and/or mechanically by means of a spring (26).

2. Arrangement according to Claim 1, w h e r e i n the outer telescopic pipe (22) at the top has a ring flange (22') oriented inward in the irection, and where

shoulder (30), a collar or a similar radial, circumferential projection formed by said annular disc-shaped flange (30), between which shoulder (30) and the lower surface of the inwardly projecting ring flange (22') is mounted a compression spring in the form of a helical spring (26).

3. Arrangement according to Claim 1, w h e r e i n the upper part of the outer pipe (22) of the telescopic pipe arrangement (18) is shaped as a cylinder (22a) for an annular piston (32) that is formed by said annular disc-shaped flange (32) and is connected to the lower part of the riser (10), which part forms part of the telescopic pipe arrangement, upper and lower packings (34, 36) defining a cylindrical chamber (38) below the piston (32), which cylindrical chamber (38) is designed so as to allow it to be evacuated.

4. Arrangement according to Claim 3, w h e r e i n the lower part (22b) of said outer telescopic pipe (22) is inswept relative to the upper cylindrical part (22a), a central, circumferential packing (36) that provides sliding contact with the lower part of the riser (10) being disposed at the transition (by 40) between the upper and lower outer telescopic pipe parts (22a, 22b), and where a vacuum pipe (42) that can be connected to a pump designed to be able to evacuate the cylindrical chamber (38) is connected to the lower end of the cylindrical chamber (38).

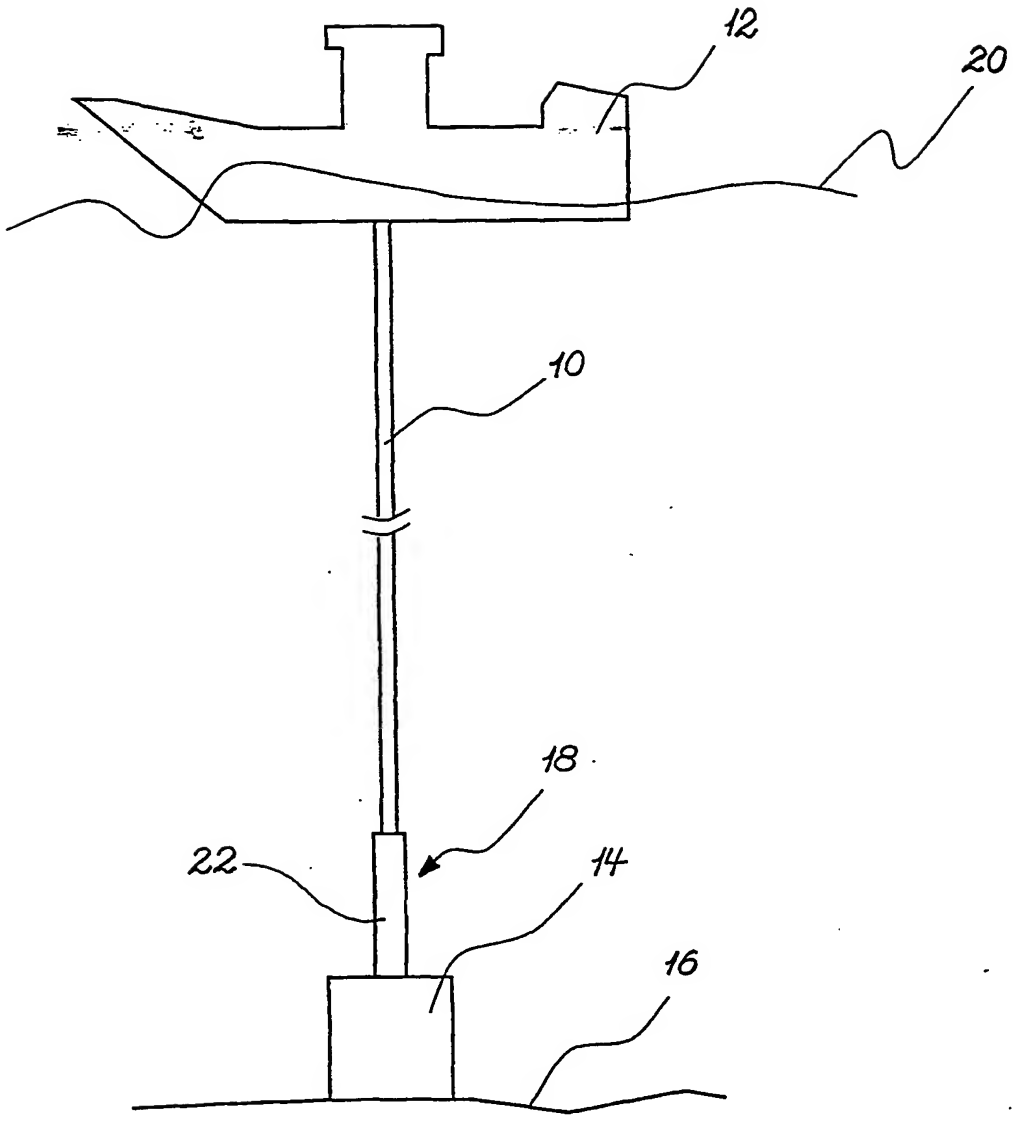

FIG. 1

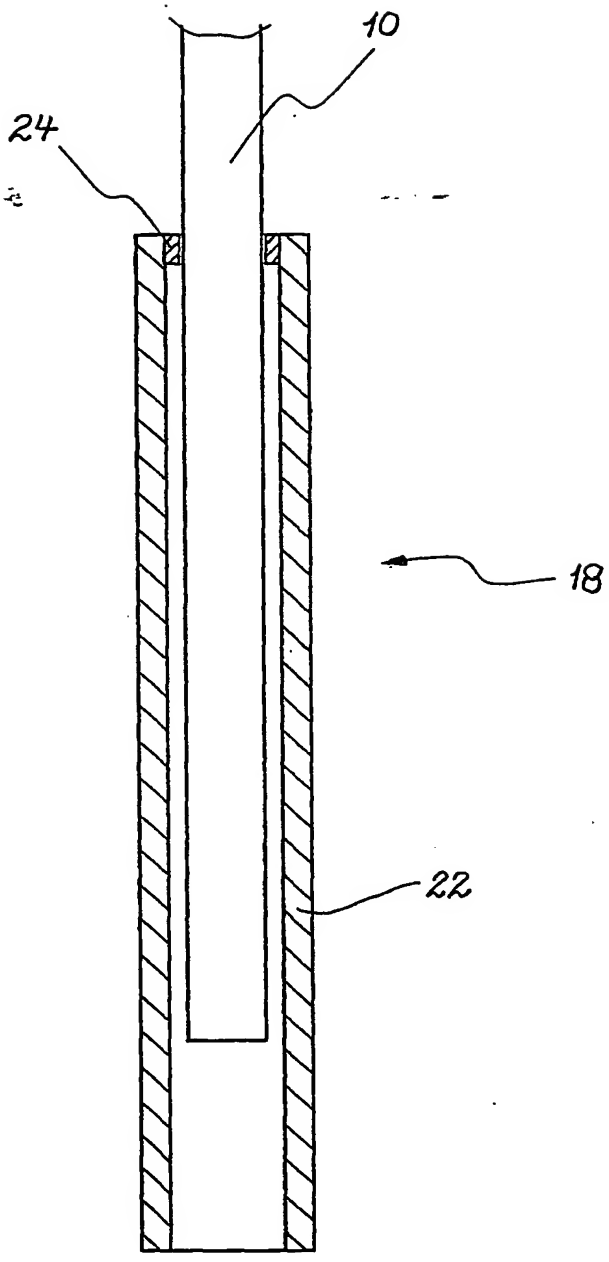

FIG. 2

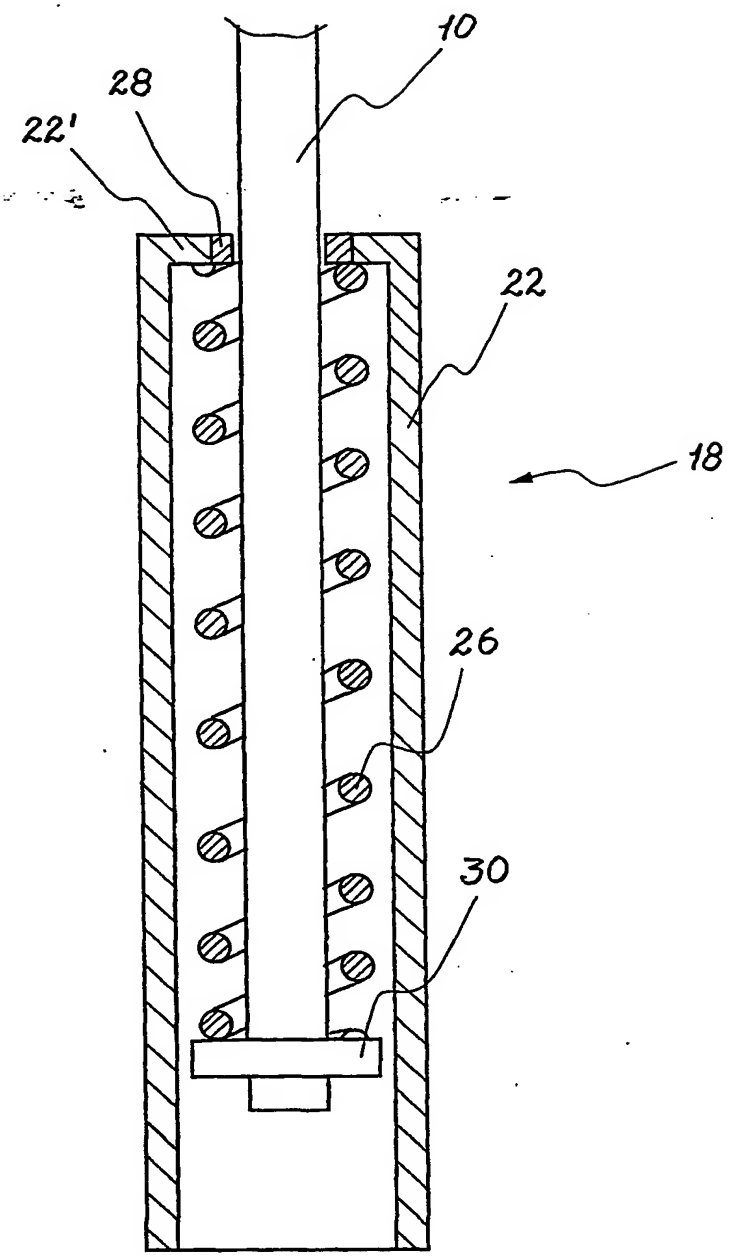

FIG. 3

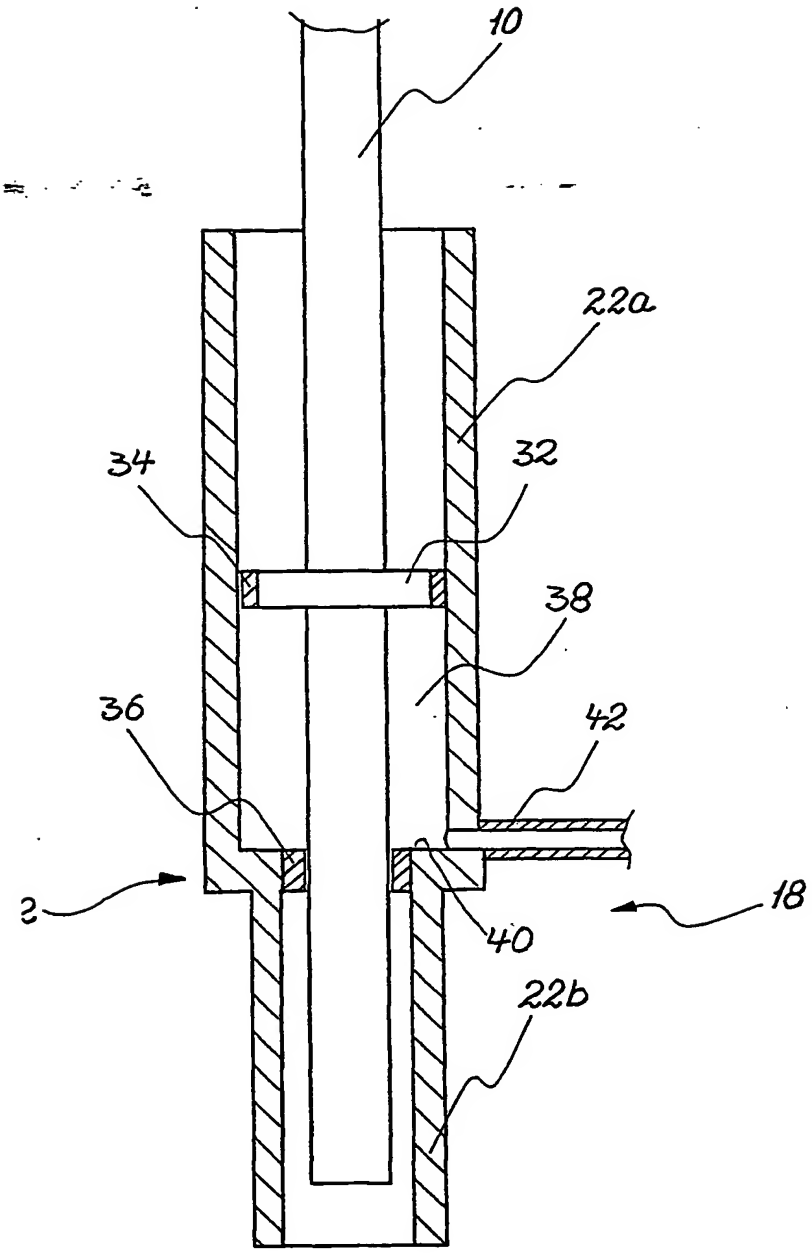

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 00/00096

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: E21B 19/09, E21B 17/01
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3211224 A (J.E. LACY), 12 October 1965 (12.10.65), column 3 - column 4, figure 2	1,3-4
A	--	2
X	US 3889747 A (A.M. REGAN ET AL), 17 June 1975 (17.06.75), column 5, line 35 - column 6, line 22, figures 1,2a-d	1
	--	
A	EP 0478094 A2 (OTIS ENGINEERING CORPORATION), 1 April 1992 (01.04.92)	1-4
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 October 2000	27 -10- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Christer Bäcknert / MRo Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 00/00096

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	NO 153700 B (TENTECH INTERNATIONAL A/S), 27 January 1986 (27.01.86) -- --------	1-4

INTERNATIONAL SEARCH REPORT

Information on patent family members

03/10/00

International application No.
PCT/NO 00/00096

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